49. Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By Frank E. Beddard, M.A., D.Sc., F.R.S., F.Z.S., Prosector to the Society.

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(Text-figures 113–121.)

VI. On an Asexual Tapeworm from the Rodent, *Fiber zibethicus*, showing a new form of Asexual Propagation, and on the supposed Sexual Form.

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I received in February of this year two complete tapeworms which were found in the hepatic duct of a Musquash (*Fiber zibethicus*) which died in the Society's Gardens. The two worms lay together in a part of the hepatic duct just before it receives the bile-duct, which was much dilated by the parasites. Although these two worms were very different in appearance, I believe them to be respectively the sexual and asexual form of the same species. I shall give reasons for this conclusion in the course of the following description of the two individuals.

(1) The Asexual Form.

The general appearance of this very remarkable worm is shown in text-fig. 113 (p. 824), which illustrates its most remarkable peculiarity, viz., the possession of two series of what appear to be buds at one end of the body. It will be seen in the course of my description of this "Cysticercoid" that it is without any doubt to be regarded as an asexual form. It does not, however, follow that the mature worm found with it is a further stage in its development. On the contrary, indeed; for as a mere matter of guesswork, the assumption would be the other way. Still, I believe that I shall be able to prove that the two worms are stages of the same species, in which event we have the very remarkable fact of both the sexual and the asexual form coexisting in the same host, and, moreover, in a situation where one would expect to meet with sexual forms only. The *Hymenolepis** of the mouse is a partly, but not an entirely, parallel instance.

At first it seems likely, from an inspection of the figure

* *H. murina.*

annexed, that the wider end of the worm is the scolex and that the narrower end is the posterior extremity where the proglottids are being shed. The dilated extremity suggests a scolex not altogether unlike that of the genus *Dasyurotænia*, which I have lately described to this Society *, and which is characterised by an unusually swelled scolex. Furthermore, there is a slight diminution in the diameter of the worm towards the narrower end, which again conforms to this view, which, as a matter of fact, I at first held myself. It appears, however, that the reverse in fact is the case, and that the narrower end is the scolex end. The opposite extremity therefore is, as I suppose, to be compared to the persisting bladder of the bladder-worm stage of the Cestode. To the naked eye, and even on examination with a lens, the scolex end presents every appearance of being the proliferating end of the body, for the last segments appear to be slightly incurved, as is so commonly the case at that end. It was not until I studied this region by means of a series of horizontal sections that I was able to discover its true relations. And even now certain important details are wanting.

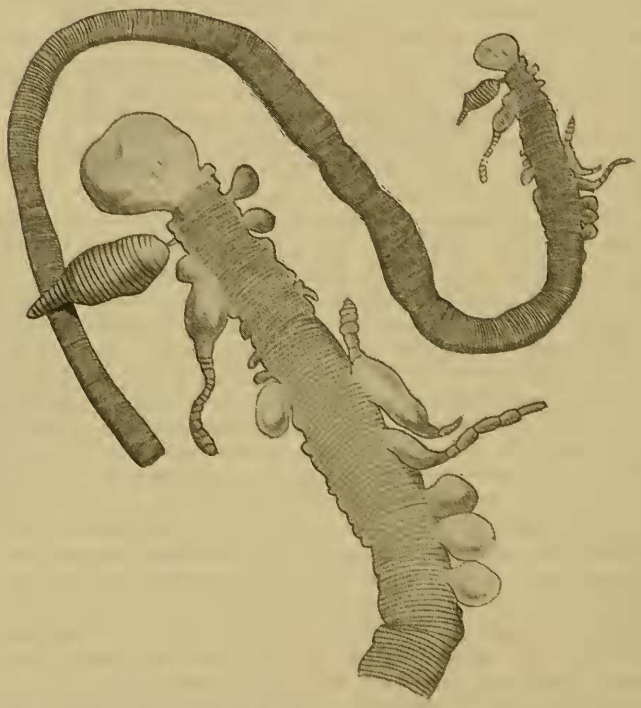
I could find, indeed, no armed scolex, nor any trace of suckers; if the worm is a member of the Pseudophyllidia and has therefore only bothria, these may easily have escaped attention in such sections, which would not be suitable for their display. I cut the sections, in fact, under the impression that I was dealing with the posterior end of the body, and without making a sufficiently exhaustive survey of the external characters. The main arguments, therefore, which lead me to the conclusion that this is really the scolex end are firstly the mode of imbrication of the proglottids, and secondly the presence of large pigment granules, a condition which would hardly be expected at the posterior end of the body, but which is not uncommon among tapeworms in the scolex. As to the imbrication of the proglottids it seems to me to be necessary to regard a segment which overlaps the next one as being anterior to it in point of origin, and therefore lying to the scolex side of it. Judged by this conclusion, the narrower end of the body of this very remarkable tapeworm is the scolex end.

There is no evidence that a scolex has been lost. On the contrary, the body ends here in a slight median elevation, which is quite unlike the termination of the body were this the region of the detachment of proglottids. This little elevation, however, bears no particular likeness to a scolex, and there are certainly no suckers or hooks to be seen anywhere. Nor is there any neck, or break of any kind, between this region and the first obvious proglottid. In this latter, moreover, the lateral and transverse tubes of the water vascular system are as large as in the more posterior segments, and do not end in a coil such as is so frequent in the anterior part of this system in other worms. It may be, of course, that the scolex is in this genus a transitory affair, as it has been

* P.Z.S. 1912, p. 677.

believed to be (though perhaps hardly now) in certain other tape-worms. Or, on the contrary, we may have here a feebly developed head like that of *Ligula*. But the great breadth of the body of the present worm is not perhaps in favour of such a supposition. Had there been a very narrow anterior neck, some suggestion of this kind might have been put forward. Anyhow, the general characters of the anterior region of the body of this Cestode are as described above. We shall recur to their more minute anatomy

Text-fig. 113.



The upper figure represents the entire asexual form of *Urocystidium gemmiparum* enlarged by about one-third. The lower figure is the posterior end of the same individual more magnified. For explanation see text.

later. From this point to the extreme posterior end are very many proglottids. They are very short and wide, and do not appear to differ very appreciably in length in different regions of the body. The greatest diameter is something like 4 mm. This is at and towards the posterior end of the body. Quite anteriorly, the diameter is not more than 2·5 mm. The length of the entire worm is about 80 mm.: the small posterior bladder is 3 mm. long

by 2·5–3 mm. wide. The proliferating end of the worm ceases abruptly with the commencement of the bladder. This region, which bears a great many lateral buds, shown in the text-figure referred to, measures 17 mm. The region of the body which bears these presumed buds (we shall consider their nature later) does not differ much from the preceding section. It looks, perhaps, a little more transparent, but it is divided up exactly in the same way into proglottids, which are of about the same dimensions as those elsewhere in the body. The buds form a row on each side of the body and are quite lateral in position; they are not at all arranged in order of growth, though representing very many stages. That is to say, the older buds alternate with younger and older forms. Nor does every proglottid bear a bud or pair of buds (one on each side). Between any two buds there was often a variable number of proglottids without any trace of budding at all. This, indeed, is necessary; for the large size of the buds would prevent their proper growth upon immediately adjacent proglottids. I counted altogether 17 buds upon one side and 18 upon the other. But I may have omitted one or two in each case; for it is a little difficult to fix the actual first appearance of a bud. They begin, in fact, as an only just recognisable rounded swelling of the edge of a proglottid. Sometimes the swelling includes two proglottids. There is no question whatever of the continuity of these buds (as I regard them) with the parent stock; they are most plainly outgrowths therefrom. In later stages the minute round bosses at the edges of the segments swell into spherical, largely transparent, vesicles, of which, as the text-figure (text-fig. 113) shows, the size varies—possibly according to age. Later still, these bladders show a young worm growing out from their distal extremity, which is usually of considerably less diameter than the bladder which is attached to the parent stock. It exhibits numerous wrinkles which I do not definitely regard as the delimitations of proglottids. The longest of these presumed young worms was about 4 mm. in length; the bladders reached a length of 2 mm. The exact number of these more developed buds is faithfully reproduced in text-fig. 113.

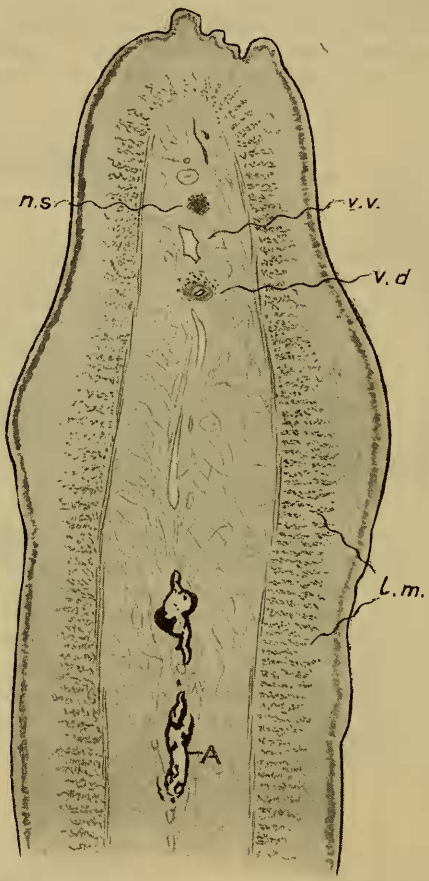
§ *Structure of the Parent Stock.*

I have investigated the anatomy of the worm by transverse, longitudinal, and sagittal sections. From an inspection of the former (see text-fig. 114, p. 826) the depressed form of the body was obvious, the diameter of a section being about seven times its depth.

At the thinner anterior end of the body, not far from the actual extremity, transverse sections showed that the medullary region of the proglottid was not more than two-thirds of the diameter of the cortical region. The two were plainly marked off from each other by delicate transverse fibres forming a very thin layer, and

yet quite unmistakable. The same proportions and the same structure were visible as plainly in the wider posterior region of

Text-fig. 114.



Part of a transverse section through a proglottid of the asexual form of *Urocystidium gemmiparum*.

A, spaces in middle of proglottid with darkly staining walls referred to in text. *l.m.* Longitudinal muscular layer of cortex, within which is seen delicate transverse layer of muscles. *n.s.* Nerve-cord. *v.d.* Dorsal excretory tube. *v.v.* Ventral excretory tube.

the body. The medullary substance is quite well stained by hæmatoxylin and has the usual homogeneous appearance. There is,

moreover, in the present worm the usual meshwork arrangement of fibrils round spherical masses of the homogeneous ground-substance such as occurs in so many tapeworms, and is often a very coarse and thus more obvious network. The homogeneous ground-substance was, however, traversed by two sets of fibres, which are, I presume, muscular fibres. These are absolutely at right angles to each other and not at all closely set in either case. The dorso-ventrally running fibres are nearly always wavy in their course, the transverse fibres are quite straight—a matter of different states of contraction, as I imagine.

The cortical layer is easily divisible into two regions, which are of about equal diameter. The innermost of these is that occupied by the bundles of longitudinal muscular fibres. The bundles of muscular fibres are two or sometimes three deep, and each bundle contains a large number of fibres, which, however, are not very closely pressed together. In addition to these bundles of rather slender fibres there lie on either side, between the nerve-cord and the lateral margin of the proglottid, two bundles of considerably stouter fibres which run continuously from segment to segment and are closely associated with a longitudinally running cavity. These bundles appear on occasions to lie actually within the cavity. This tubular cavity is not at all like the tubes of the water vascular system, and it lies within a very lax tissue. I am unable at present to suggest its nature.

The accompanying text-figure (text-fig. 115, p. 828) illustrates a section through the hinder part of the worm not very far in front of the budding region. This region shows very plainly a system of irregular spaces in various parts of the body belonging to the water vascular complex. It may be remarked first of all that the dorso-ventral diameter is greater here than in the more anterior part of the body. The structure of the vertical and medullary regions is the same, but the lower central region of the medulla actually forms a cavity (text-fig. 114 A) which I do not think to be artifact and which may be a forward extension of the cavity of the terminal bladder, though I have not proved the fact, from an unwillingness to sacrifice the specimen altogether. The interior lining of the space was, however, so very strongly stained as compared with the surrounding tissues that it appears to me to be practically certain that the staining fluid gained access through the two cut ends of the piece of worm, which was stained *en bloc*. This, of course, argues a continuous central cavity.

It was quite plain that this cavity was quite distinct from that of the transverse water vascular trunk. The peculiar central cavities occupying nearly the middle of a segment here and there, referred to later (see p. 830) in describing sections made from earlier segments in the body, are present here and are again not to be confused with the central lacuna. Their thick walls show no trace of an opening into it. In addition to the main trunks of the water vascular system, which are disposed here as they are elsewhere in the body, there are scattered irregular spaces which

seem to belong to the same system. These consist of larger but very short stems with finer branches. I have not traced any connection between these tubes and the main stems of the excretory system; but I can, nevertheless, hardly doubt that it exists.

Text-fig. 115.

A more highly magnified section through excretory vessels and adjacent structures of the asexual form of *Urocystidium gemmiparum*.

d.v. Dorsal vessels surrounded by circular muscle-fibre. *m.* Layer of transverse muscle-fibres separating the cortex (to the right) from the medulla (to the left). *n.* One of several tubes forming the excretory network and lying, as is shown, in the cortex as well as in the medulla. *t.v.* Transverse commissural vessel forking to join the ventral vessel (*v.v.*), which is also bifurcate to receive the branches.

These ramifications lie in the cortical layer as well as in the medullary (text-fig. 115, *n*). In one case I observed a narrow duct leading from a wider space to the exterior—at any rate, most

undoubtedly to the cuticle, and in other cases it appeared to me to be highly probable that the ramifications of these tubes do open on to the exterior here and there; they at least invade the outermost layer of the cortical tissues.

The *water vascular tubes* are large in this species, and not far from being equisized. There are, as is the rule, two upon each side of the body. As is so often the case among the Cestodes, the two tubes, instead of being respectively dorsal and ventral and superposed, lie side by side. As is also quite usual among these worms, the two tubes, dorsal and ventral, differ somewhat in structure. I consider that the slightly smaller and more muscular of the two tubes is the dorsal vessel, from the analogy of other forms; in the present species, therefore, the dorsal vessel is situated internally to the ventral. They are, however, quite in the same straight line for the most part and also in the same straight line with the nerve-cord. But, as a matter of fact, the more muscular dorsal tube lies in a corkscrew fashion, which is very plain when the proglottids are viewed in longitudinal and sagittal sections, and thus that tube in cross-sections appears to lie now rather dorsal of, and at times rather ventrally of, the ventral and more external vessel. Elsewhere they are more directly in the same straight line. It is a remarkable fact that both of these vessels seem to be quite as large or very nearly so in the most anterior segments of the body. There is no great increase in calibre posteriorly.

The general relations of these two vessels are shown in text-fig. 114. Text-fig. 115 is a more enlarged representation of the two tubes and the adjacent parts taken from a section of the posterior region of the body. Their detailed structure is there illustrated. In his account of the Cestoidea in Bronn's 'Thier-reichs,' Prof. Braun remarks "Ob in der Wand der Sammel-röhren auch noch Muskelfaseren vorkommen, ist noch strittig." The figure just referred to is, as I think, quite conclusive as to the presence of a particularly thick layer of circular fibres constituting the greater part of the wall of what I regard as the dorsal vessel. This muscular layer appears to wax and wane in thickness from place to place. But it is always thick and thus very apparent. The actual tube is lined with a chitinous cuticle which is also often very thick and everywhere to be seen. Outside of the layer of circular muscles are abundant nuclei, massed round the tube. I did not observe any nuclei among the circular muscular fibres, which are, indeed, very closely contiguous. There appear to be no intrinsic longitudinal muscles to assist in the widening of the tube again after contraction by the circular muscles; but there is a mechanism which takes the place of such fibres to serve in their stead.

In the neighbourhood of the dorsal excretory vessel the dorso-ventral muscles form groups here and there of rather thicker and more closely adpressed fibres, which, as it were, tie to or suspend the dorsal vessel from the cortical layer; it seems certain

that the contraction of these would dilate the lumen of the dorsal excretory tube. These fibres, which exist both dorsally and ventrally, have a somewhat fan-like arrangement—that is to say, they converge upon the vessel from above and from below. It is these various muscular layers which cause so great a variation in the lumen of the excretory tube from place to place.

The ventral vessel differs entirely from the dorsal by the entire absence of any muscular layers and by the possession of only a very thin lining cuticle. It follows, therefore, that the variations in the calibre of this tube are not so great, and when they do occur seem to be due to a squeezing by the surrounding tissues. The ventral vessel also runs a much straighter course than the dorsal without any marked corkscrew-like windings exhibited by the latter. There is a transverse vessel in each segment which has a rather peculiar relation to the ventral longitudinal tube into which it opens on either side of the body. A little way before reaching the dorsal tube the transverse vessel splits into two halves, which embrace the dorsal vessel and open separately into the ventral vessel. This is partly shown in text-fig. 115.

We have now to deal with a series of sac-like bodies forming closed cavities of very problematical nature, which lie in the middle of many segments. There is by no means one of these sacs to each segment, and thus they are very far from constituting a tube running without intermission through the body. I compare them, however, later in this paper to a tube found in the young buds (see p. 833). But, as a matter of fact, one of these sacs may actually extend through two proglottids, so that there is a hint of a formerly continuous structure such as occurs in the buds. As a rule, however, they appear to be limited to a single proglottid, of which they occupy sometimes the exact centre, at other times pushed rather to one side. They lie close to the transverse water vascular vessel. I cannot find that these sacs have any connection with any other spaces. They appear to be perfectly isolated. The first of the series occurs very early in the body—if not in the very first segment. These sacs have a lining cuticle surrounded by a single layer of epithelial cells of which the borders between the individual cells are not clear. The nuclei, however, are very obvious and large. There are no muscle-fibres at all apparent encircling the sacs. They often appear crumpled in transverse sections, and occasionally seem to be Y-shaped. They are impossible to miss in a series of sections.

The only remaining characteristic of this worm upon which I am able to report is the structure of the "head" end of the body, which has been already briefly described above. In the place of a scolex there is a small projecting process, no larger than the rostellar process of many unarmed tapeworms. This arises from the middle of what may be termed, for the present, the first segment of the body, which is distinguished from those that follow by its rather less breadth and greater length. It would seem to

be really composed of two segments, if we consider the condition of the water vascular system therein. The two main longitudinal vessels of this system extend well forwards into this compound segment, and the outer ventral vessels are connected by two transverse vessels, thus indicating, as I suggest, the double nature of this apparently single segment. Towards the centre of the specialised anterior segment is a large group of deeply-pigmented oval bodies, which appear to be special pigment-cells. They are as large, or nearly so, as the calcareous corpuscles which are very abundant in this worm. In the middle of the concave anterior border of these two fused segments is quite a small conical projection, than which nothing else at all comparable to a scolex exists. There is no sign of any breakage at the summit of this which might suggest that a scolex had been accidentally detached.

It is a somewhat remarkable fact that these conditions (or, at any rate, something very near to them) occur in the genus *Dioicocestus*; for, as will be pointed out later, the genus with which I am concerned in the present paper shows some likeness to the Acoleidæ and even to the genus *Dioicocestus*, which is of that family. In *Dioicocestus acotylus*, Fuhrmann * has described and figured the practical absence of suckers and the very rudimentary condition of the rostellum—a state of affairs which is not found in the other species of this genus. The figure referred to also shows—as I have described in my species—the absence of any marked diminution in calibre of the body at the head end. But it must be remembered that the *Dioicocestus* was a fully-developed sexual worm.

§ *Structure of the Buds.*

It now remains to consider the minute anatomy of these outgrowths and their nature. As to the latter query, there are, as it appears to me, only two alternatives. These outgrowths must be either "tentacles" of the nature of the processes known in *Hymenolepis villosus*, or young worms budded off from the parent stock. There is very little, if indeed anything, to be said in favour of the former view. It is true that a large outgrowth of the body to form a tentacle might have very much the same structure as the body, even to possessing branches of the excretory system and lateral nerve-cords. But there would hardly be a practical identity of structure such as I shall point out in detail later. Furthermore, the growth of processes of the body might be expected to be more regular than are these outgrowths (*cf.* text-fig. 113), and above all a gradual freeing of themselves from firm contact with the body, as shown in the figure, is precisely what we should expect with budding offspring, which, as it appears to me, is the obvious and only way to interpret these appendages of the fully grown worm.

* Zool. Jahrb., Abth. f. Syst. Bd. xx. 1904, p. 131.

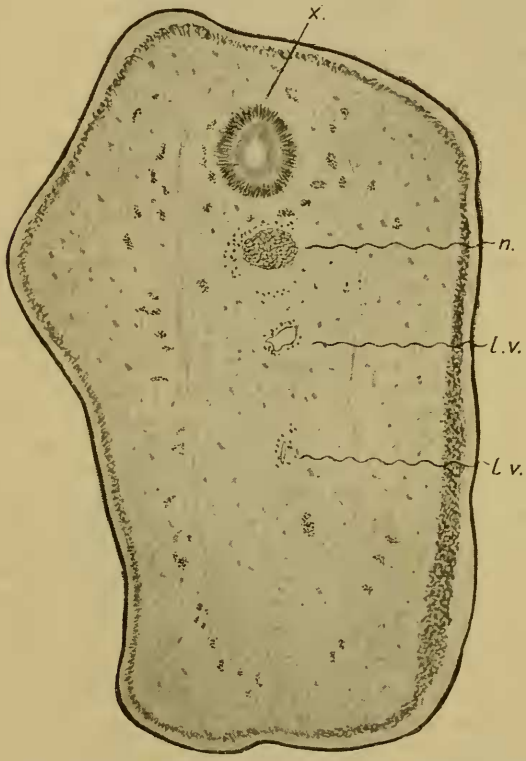
I selected for investigation, by means of transverse sections, the most adult-looking of the young budded-off worms, in which, moreover, segmentation was obvious. I have already referred to this individual in my account of the budding process and need not redescribe its external characters here. The wider end attached to the body of the parent forms a bladder with rather thick walls. This I take, therefore, to be the posterior end of the young worm. The opposite end is very much thinner (as is, of course, usual among tapeworms) and represents the scolex end of the animal. I could observe no trace of hooks anywhere on this scolex, nor suckers of any kind. This, however, is not surprising in view of what I have already described in considering the conditions observable in the parent stock. At about the middle of the worm a transverse section shows the appearances represented in text-fig. 116. The cortical layer is thick—about the same diameter, or in places rather more than the diameter, of the medullary region. The medullary region is plainly marked off from the cortical by transverse muscular fibres of delicate constitution.

There are several parallel fibres in this layer, which is altogether of some width, the individual fibres being widely separated. The parenchyma of the medullary region is as usual, and contains many nucleated cells, generally triangular in form, connected with processes at the angles. These cells get to be particularly numerous near the water vascular tubes, which will be referred to later. There are also heaps of nuclei visible in some sections, which I take to be the rudiments of the sexual organs. To one side of the body the medullary region seems at first sight to be invaded, as it were, by the cortical region, thus producing an asymmetry in the transverse section, which is quite apparent in the accompanying text-figure. This asymmetry is associated with the presence of a tubular organ (text-fig. 116. *x*), which will be described in detail on a subsequent page. This occupies a good deal of space, and round it are large bundles of stout muscular fibres, quite similar to those which occur in the cortical layer. It is very easy, however, to observe that the transverse layer of muscles bounding the medullary parenchyma is continued on either side of this differentiated mass of tissue and ends laterally at a point asymmetrical with its ending on the other side of the body. I therefore regard this region as belonging to the medullary part of the body. The cortical region is distinguished from the medullary (other than that section of the medullary region just referred to) by the bundles of stout longitudinally running fibres. These bundles form a layer immediately outside of the transverse fibres; but there are much smaller bundles and isolated longitudinal fibres extending some way towards the exterior of the body.

In the medullary region lie the water vascular tubes and the nervous system. All of these lie in the same straight line with each other and with the tubular organ already referred to, and

this line is the longer diameter of the cross-section ; the tubes etc. are thus laterally disposed with regard to each other. It is necessary to emphasise what may appear to be a statement of the obviously true, since in other regions of the body the mutual relationships of these several organs and systems are a little changed.

Text-fig. 116.



Transverse section through middle of strobila of oldest bud of the asexual form of *Urocystidium gemmiparum*.

l.v. Excretory tubes. *n.* Nerve-cord. *x.* Tube of doubtful significance described in text.

In all other tapeworms known to me the water vascular tubes of the two sides of the body are symmetrical with each other in point of position within the medulla and distance from the lateral cortex on either side. They are also generally correspondent in size, though not always regularly so throughout the whole body. In the present species the water vascular tubes are asymmetrical in both these particulars. The tube of the one side is considerably

larger than that of the other and is relatively asymmetrically placed. This latter fact is doubtless due to the bundles of longitudinal fibres surrounding the large lateral tubular organ. This structure has, as it were, pushed the nerve-cord and the water vascular tube of its side towards the centre of the body. Indeed, the vessel in question lies very nearly in the actual centre of the section and quite in this position shortly before and during its connection by the transverse vessel with the tube of the opposite side of the body. These transverse vessels are at regular intervals and quite easy to see as in the adult worm. I did not observe any other branches of the water vascular tubes than these.

These sections from the middle of the body of the young worm also show very plainly the remarkable constitution of the nervous system in this Cestode. One of the two lateral cords (text-fig. 116, *n*) is very obvious indeed, lying between the water vascular tube of that side and the tubular organ of doubtful meaning. It cannot possibly be missed in these sections. But on the opposite side of the body I could find no trace whatever of any nerve-cord even of smaller size than the one represented in the text-figure. I feel confident that a failure to observe a cord in this situation, were it present, would be difficult. The medullary tissue is so clearly differentiated by the stain (iron hæmatoxylin *) that the nerve-cord, if of any size at all comparable to that of the opposite side of the body, would stand out quite prominently. This state of affairs is undoubtedly very anomalous and hard of explanation. For we shall see later that the two nerve-cords are both quite recognisable towards the end of the body.

Finally, this transverse section shows to one side a large tube cut across, to which reference has been made incidentally once or twice already. It is situated in the centre of a group of bundles of longitudinal fibres, which bundles are like those in the cortical layer of the body in every way, including their rather sparse scattering round the centrally placed tube. The bundles in the cortical layer are not densely pressed together as they are, for example, in *Dasyurotænia robusta* †. The tube itself is of considerable size and is lined by a thick layer of chitin, which is stained precisely like the chitin which covers the body of the worm externally. Outside of this is a single layer of stout longitudinal muscle-fibres, and then a deeply staining layer of elongated cells, interspersed among which are small bundles of stout longitudinal fibres. The structure of the tube is in fact almost exactly that of the outer layer of the body, only differing, indeed, by the intercalation of the groups of stout longitudinal fibres among the cells.

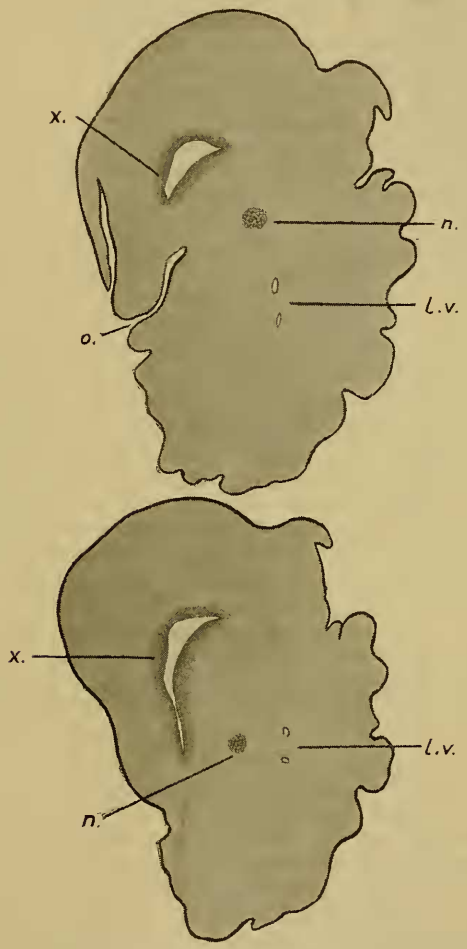
We shall now consider the course and structure of this tubular organ throughout the body of the young worm. The identity of structure with the outer layer of the body which this tube shows in the middle region of the body, is rendered intelligible

* I am indebted to Dr. Plimmer, F.R.S., for the use of this reagent.

† See Beddard, P. Z. S. 1912, p. 684, text-fig. 97, *l.m.*

by the fact that in two places, one behind the other, it communicates with the exterior by a narrow duct (text-fig. 117). One of

Text-fig. 117.



Two consecutive sections from another region of the same bud as that which is represented in text-figure 116, to illustrate the opening of the tube x on to the exterior.

In the upper figure the orifice (*o.*) on to the exterior is shown and the commencement of the invagination leading towards the tube x.

In the lower figure the outgrowth of the tube x to meet the invagination is seen.

n. Nerve-cord. *l.v.* Water vascular tubes.

these openings is in the bladder region and the anterior one a very little way in front of this. Both orifices are dorsal or ventral* in position—at any rate not lateral,—but they do not coincide exactly. In view of the position of these orifices it is clear that the tube of communication is of some length. In addition to these two openings on to the external surface, the tube gives off two short cæcal processes, one of which nearly but not quite opens into the bladder.

Anteriorly the tube gradually comes to an end and does not end by opening on to the exterior. It diminishes in calibre for the space of a few sections and then simply ends. At the bladder end of the body—the end which is attached to the parent stock—the tube gets to be more and more shoved to the side as the bladder increases in size. In consequence also of this the tube becomes flattened from side to side, at the anterior part of the bladder. Followed backwards this tube can be recognised by its thick chitinous lining, already referred to, and can be seen thereby to be quite distinct from the excretory tube which has come to lie below it in consequence also of the development of the bladder region. The next that occurs is that the tube divides into two coincidently with the formation of two or three septa, partly dividing up the cavity of that part of the bladder which lies adjacent. The two tubes lie one dorsally to the other, and thus both of them in the same straight line with the excretory tube. The middle tube of the two after a very short course appears to open into one of the chambers of the bladder, and is thus a diverticulum like the one mentioned above. Furthermore, I am not absolutely certain that it actually opens into the bladder; but it ends at least in close contact.

I feel, indeed, almost inclined to assert that this tube does open into the cavity of the bladder, since the main tube, continuing a little way further back, gets very narrow and undoubtedly ends by opening into the bladder. It is to be noted that these orifices do not involve a mere continuity of lumen. The character of the lining membranes changes at the point of meeting. It is further to be noted that it is not the main cavity of the bladder into which the tube opens, but into a portion of it, separated off by septa. This problematical tube varies in parts in its structure and in its relations to the nerve-cord. Anteriorly the layer of cells surrounding it are not so conspicuous as elsewhere, and thus the longitudinal muscular fibres come into greater prominence; the calibre of the tube also is not the same all through the body. It has been mentioned that in a section from about the middle of the body, that the tube lies outside of the nerve-cord and quite laterally to it. In other parts of the body, particularly anteriorly, the tube lies above (or, perhaps it may prove necessary to say, below †) the nerve-cord.

We have, therefore, in these young worms still attached to the

* I cannot differentiate between the dorsal and ventral surfaces.

† See footnote above.

parent, though (as the narrow stalk shows) just ready for detachment, a tube of the structure of the outer layer of the body which traverses in a straight line nearly the whole of the body, which opens into the bladder behind and has two segmentally-arranged orifices of communication with the external world. There is no obvious answer to the question as to its nature. In buds within the cyst of *Echinococcus* * a cavity is formed which is not an ingrowth of the cavity of the whole cyst, but which is alleged to be continuous up to the scolex. This, however, has been denied and the scolex asserted to be entirely solid. But even supposing a comparison is possible on the grounds that the scolex of *Echinococcus* is hollow, the short tubes leading to the exterior in the worm of which the present paper contains an account would seem to invalidate it. And, moreover, the structure of this problematical tube is not that of the bladder with which it communicates. It seems, indeed, to be a special structure and not a space connected in any way (or, rather, any *direct* way) with an evagination of the scolex.

For the greater part of the body I could only find a nerve-cord on one side, where it was quite as obvious as in the "adult" worm. In the anterior region, however, the nerve-cord of the opposite side was visible for a short space. It was, however, not half the size of its fellow, though of precisely the same structure and equally unmistakable as a nerve-cord. Both cords lie in the medullary region just at its bordering on the cortical layer. I could find no enlargement of the nature of a brain. Quite anteriorly, as well as posteriorly in the bladder region, I could not recognise a nerve-cord. It is noteworthy that the asymmetry of the two water vascular tubes in size is exactly paralleled by that of the two nerve-cords.

These are the facts which I have ascertained in the anatomy of the most mature of the growing buds. It now remains to compare the structure of the young worm with that of the parent stock of which it is a bud.

§ *Comparison of Bud with Parent Worm.*

In the general form of the body and in the possession of a relatively small bladder they agree; also the rudimentary scolex is a marked feature of both young and old.

It is rather remarkable to find asymmetry in the young worm, but this of course may be its normal method of growth. Certainly I noticed no asymmetry in the parent form. What is perhaps important as a difference is the presence of only two water vascular tubes in the young and four of these in the older worm. The additional water vascular tubes may, however, make their appearance later. Furthermore, for the same reason, too much stress cannot be laid upon the more copious

* Bronn's Thierreichs, iv. Abth. 1 D, p. 1549.

bundles of longitudinal muscular fibres which are to be noted in the large worm. I believe also that the continuous large tube in the immature worm is represented by the cavities contained in many of the segments of the adult worm, though the minute structure, it must be confessed, differs in the two cases. Furthermore, the series of cavities in the adult worm lie very nearly in the middle of the body, indeed quite in the middle of the body in some segments; the tube in the young worm is, on the other hand, as distinctly to one and the same side. But it must be borne in mind that the position does vary in the young worm, and a further flattening of its body might easily cause a greater similarity in the position of the tube to that observable in the more fully mature worm.

§ *Comparison with other Forms and Systematic Position of the Parasite.*

Apart from the question of proliferation by budding, to which we shall return later, this Tapeworm presents a certain number of undoubted resemblances to *Cysticercus fasciolaris* (of rats and mice, etc.), which becomes *Tænia crassicollis* in the Cat. Both these forms agree (I have compared the species which forms the subject of the present paper with examples of the *Cysticercus* from the common rat) in possessing a long segmented body and a small bladder posteriorly. But in *Cysticercus fasciolaris* the bladder is smaller and the body shorter than in my species, while the hooked and suckered anterior end renders any confusion or detailed comparison impossible. Nevertheless, the two forms have in common the small bladder and long strobila. But while the one occupies the position in the body of its host of a sexual worm, *i. e.* in a diverticulum of the alimentary tract, the other is found, as are *Cysticerci*, encysted, and in the liver of its intermediate host. Nor is it by any means certain that the species from the Musquash is a member of the Tænioidea (Cyclophyllidea) at all. It may well be a member of one of the lower groups of Cestodes. We shall consider the arguments for and against the placing of the worm among the Tænioidea.

It must be admitted at once that there are no absolutely conclusive arguments which point definitely one way or the other. This, of course, may be explained on the assumption that we are dealing here with quite a new type of Cestode. In the meantime, the structure of the worm so far as it can be read does not favour such an assumption, though it does not, for the matter of that, appear to be necessarily contradictory of this possible view. As to the other alternatives, the absence of a marked scolex with suckers is greatly against the reference of the worm to the Tænias, but the character of the terminal bladder, on the other hand, is on the whole in favour of such a placing. This latter fact is obviously against the supposition that the worm is a Plerocercoid of any kind; but the lack of a definite "head" is as clearly in favour of

this supposition. There, as it appears to me, the question must be left—in regrettable uncertainty.

The process of asexual reproduction by budding which this worm shows is not entirely unknown among the Cestoidea, but there are some not unimportant differences from what has been recorded in other forms. There are two principal comparisons to be made.

The first of these is with *Cysticercus longicollis*, the bladder-worm of *Tænia crassiceps*. It is of further interest from the point of view of the present comparison to note that this *Cysticercus* is also found in a Rodent, *Arvicola arvalis*. Besides the earlier investigators, Prof. M. Braun* has studied this form and embodied his results in brief in Bronn's 'Thierreichs'†. The buds from the *Cysticerci* do not apparently contain a prolongation of the bladder-cavity, "sondern durchweg als solide Wucherungen der peripheren Schicht der Wand entstehen." This is an obvious point of similarity with my species, where, of course, the buds cannot be continuous with the cavity of the bladder—that is to say, in both cases the buds are solid outgrowths. Furthermore, before being separated off from the parent *Cysticercus* the attachment of the bud dwindles to a narrow stalk precisely as I have described above. The buds, however, in the case of *Cysticercus longicollis* seem to be limited to the bladder and always to the hinder end of that; whereas in my species this is exactly the region where no buds are formed.

I believe, however, that a nearer approximation to the condition observable in the species which I describe in the present paper is offered by a worm recently described by Ijima‡ with some detail. This is a *Plerocercus* or Plerocercoid found parasitic in a human being in Japan in cysts in the skin. It appears to give off actual buds, which are, however, more or less irregularly arranged and present nothing of the comparative symmetry manifested in the species from *Fiber zibethicus*. The individuals differ in the degree of their budding, some giving off a large series of slender processes. These buds are, as in my species, actual outgrowths of the parent stock and not, for instance, connected with the excretory organs or any other definite part of the body. They occur as much at the head end as elsewhere and there differ from the Tapeworm of *Fiber zibethicus*. There is, however, a resemblance, in that in both cases the more mature buds are not in front of or behind the less mature: there is a complete irregularity in their order of succession.

The similarity between the two cases of budding cannot, however, be carried into any detail, since it is obvious that the two worms are not nearly allied. The Plerocercoid described by

* See Centralbl. f. Bakt. u. Par. xx. 1896, p. 580; Zool. Anz. 1896, No. 514; *ibid.* 1897, No. 521. These papers are not illustrated.

† Bd. iv. Abth. 1 B, p. 1529.

‡ "On a new Cestode Larva parasitic in Man," Journ. Coll. Sci. Japan, xx. 1905. For a reference to this paper I am indebted to Dr. W. Nicoll.

Ijima is regarded by him—and, as I think, rightly—as a young Bothriocephalid whose larval stages are also known from similar positions in other mammals than man. These larvæ have no bladder, and thus the fact that in the Plerocercoid, as in my worm, the buds are produced from the general body surface loses its principal significance. It is, I think, more important to note that the worm from *Fiber zibethicus* differs from *Cysticercus longicollis*, in that the budding is not upon the bladder end of the worm. It is remarkable, however, that both in my worm and in the Plerocercoid there is no recognisable scolex; but at the same time there is in the supposed young Bothriocephalid no proper segmentation of the body as yet visible. It is thus particularly remarkable that my species is very fully segmented throughout. I think, therefore, that the case of budding which I bring forward in the present paper may be regarded as in some respects a new form of asexual reproduction which is partly paralleled in a few other forms of Tapeworms.

Inasmuch as the propagation of this worm is different in detail from anything that is known, and as the worm itself does not entirely conform with any known species or genus, it is desirable, as I think, for mere convenience sake to give it a name and to define as far as may be the characters of the Cestode. Had the worm proved definitely a Tetracotylean*, I should have contented myself with referring it temporarily to the genus "*Tænia*," a name which is generally given to forms whose generic affinities are uncertain. As, however, this cannot be done with any certainty, I venture to give a new generic name which is non-committal as to its position in the series, and I term it accordingly

Urocystidium gemmiparum, gen. et sp. n.

Incompletely mature worm with small bladder and very numerous proglottids. Scolex feebly developed and without hooks. Tubes of water vascular system lateral to each other, the dorsal with thick muscular coat and inside of ventral, the ventrals connected by a transverse vessel which forks and surrounds dorsal vessel; a network present in cortex as well as in medullary region. Longitudinal muscle-layer in cortex of at least two rows of bundles with numerous fibres in each. Buds formed at hinder end of body on both sides, thus forming two rows, of which the bladders are attached to the parent stock; the scolex is not inverted, is without hooks, and rudimentary.

Hab. Musquash (*Fiber zibethicus*), in liver-duct.

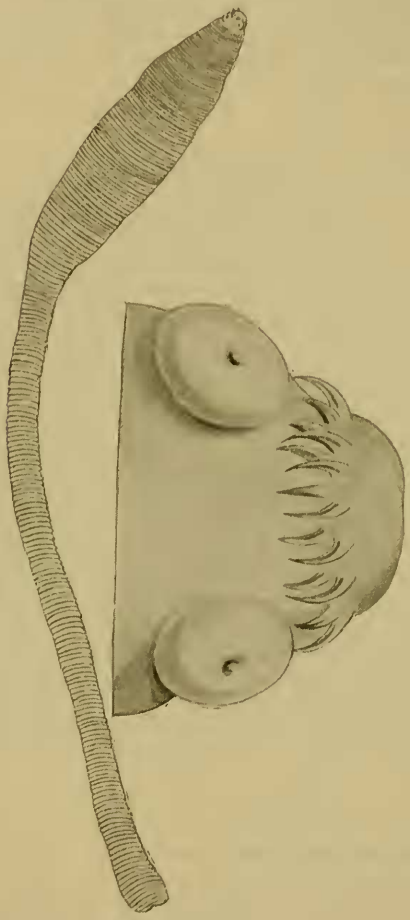
(2) The Sexual Form.

As has been already mentioned, the hepatic duct contained besides the "cysticercoid" just described a sexual worm which I

* I think it necessary to maintain an attitude of reserve with respect to the identity of the asexual and sexual forms.

believe to be the mature form of the same Tapeworm. The size of the two worms was about the same. The sexual form measured 86 mm. in length and the greatest diameter, which occurred not

Text-fig. 118.



The sexual form of *Urocystidium gemmiparum* (?).

The left-hand figure represents the entire worm magnified about twice; the right-hand figure represents the scolex with a double crown of hooks more highly magnified.

far behind the head, was 6 mm. The appearance of the worm (text-fig. 118) was quite similar to that of the immature form. It

was posteriorly of a rather delicate appearance, rather translucent, and the proglottids were very short and enormously wide in proportion. There was no increase in length of the proglottids towards the end of the body, and their proportions were as in the asexual worm. It would hardly, of course, be sufficient to insist upon an identity upon these grounds alone; but, taken in conjunction with other facts which will be dealt with, the similarity in outward appearance is very striking. The "tail" end of the body appeared to be a little excavated, as is common in tapeworms, the penultimate segments slightly embracing the last segment, which was not quite so wide. I can believe that the worm was proliferating at this end.

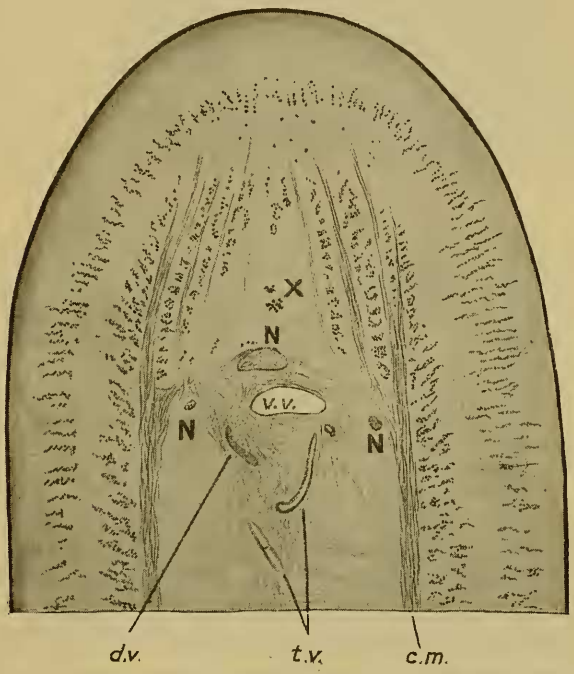
The scolex was not quite so wide as the ensuing strobila, and no appreciable neck separated the two. The scolex is proportionately large, as is indicated in the accompanying text-figure (text-fig. 118), and well armed anteriorly with two rows of hooks alternating in position. The anterior circle of hooks consisted of 16 separate hooks, which were about twice the size of those of the succeeding circle, whose number I did not count, but which were presumably the same, as they were implanted between the larger hooks. The usual four suckers are present; they show no unusual features and are unarmed; their cavity looks forwards.

I have investigated the internal structure by means of transverse and sagittal sections. The cortical layer does not differ greatly from the medullary layer in thickness, and the general appearance of the sections is very like that of sections of the immature worm (see text-fig. 119). The cortex, for example, is identical or nearly so. The same bundles of longitudinal fibres occur and are very much of the same thickness. They are also separated from the medulla by transversely running fibres. I have described and figured in the asexual form the bundle or bundles of rather stouter longitudinal fibres running outside of the nerve-cord on either side and associated with a cavity dubiously related to the excretory system. I find the same arrangement in the sexual worm.

The *excretory system* does not need a very long description, since it agrees in its main peculiarities with that of the supposed asexual form. There are, in fact, the same two lateral vessels on either side lying parallel to each other. They are, moreover, roughly equisized, and the innermost of the two has very thick muscular walls, the fibres being circular in their disposition. I should add that nuclei interspersed among these fibres were very obvious. In addition to these two longitudinal trunks each proglottid possesses a transverse vessel which has the same remarkable mode of union with the ventral excretory tube that I have figured (see text-fig. 115) and described (see p. 830) in the presumed Cysticercoid stage, and which I need not redescribe here as the structure seems to be identical. There is, however, one important difference which the sexual form shows from the Cysticercoid; and that is the absence in the former of the peripheral water vascular

network of the latter. I could find no trace of this in the sexual worm, although it was easy to see in the supposed Cysticercoid of the same. It seems to me possible (perhaps necessary) to explain this difference by assuming in the Cysticercoid a retention and gradual metamorphosis of the bladder into the strobila, together with its excretory system, which latter ultimately disappears on the assumption of sexual characters. There are, of course, other Cestodes in which the bladder is not cast off before the acquiring of sexual characters.

Text-fig. 119.



Part of a transverse section through a proglottid of the sexual worm.

c.m. Circular muscles. *d.v.* Dorsal vessel of the water vascular system. N. The three laterally running nerve-cords. *t.v.* Transverse water vascular trunk. *v.v.* Ventral trunk. X. Large longitudinal muscular fibres referred to in the text as frequently running withiu a space.

In the neighbourhood of the water vascular trunks delicate muscular fibres are shown running chiefly in a dorso-ventral direction, which may be associated with the dilation and contraction of the water vascular tubes.

The *nerve-cord* shows no trace of the asymmetry which I have described above in the very young worms. There is nothing unusual about the position or structure of the main trunks. There

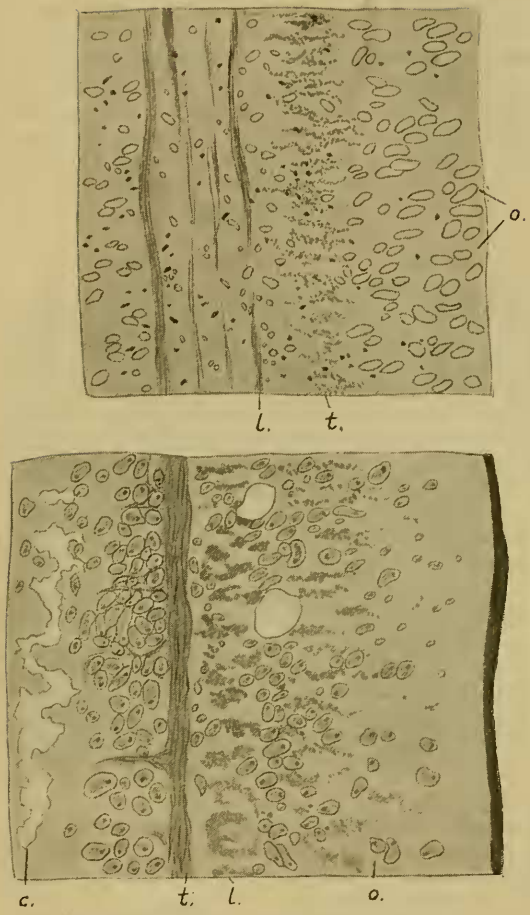
is, however, on either side of the body and running parallel with the main nerve-cord a second and a third nerve-cord (see text-fig. 119, N) which lie above and below the former and at some distance from it. These accessory nerve-cords appear to be exactly like the main nerve-cord in structure and are situated at the boundary of the medullary and cortical regions, a trifle nearer to the middle of the segment. In sagittal sections the supplementary nerve-cord is very obvious and is seen to be connected with the main trunk by numerous (7 or 8) transverse cords in each segment, which produce a ladder-like appearance. There is an obvious likeness here to *Bertiella*, in which genus the nerve-cord also consists of three separate strands, and to *Dioicocestus*, where the cords are wider apart. They are, however, much closer together in *Bertiella* than in the present worm. I have not observed this arrangement of three nerve-cords in the supposed immature form already described. But it is to be observed that the main cord is there almost as wide as the medulla, thus leaving no room for the accessory cords which may be split off later.

§ *Sexual Organs.*

In the middle region of the body and possibly for some way in front (I have not examined sections just in front of the mid-region) the proglottids are full of ripe eggs. I have examined these proglottids in sagittal as well as in transverse sections. The former bring out the important fact that there is apparently no internal boundary-line between the proglottids; for the eggs form continuous masses stretching without intermission from segment to segment. In this region the most careful search failed to show any other genital organs than these exceedingly numerous ripe ova. It is, of course, not uncommon in fully mature segments of tapeworms, such as these in the present form, to find nothing but ova in the medulla; but in those forms there are at least considerable though often altered remains of the genital ducts and terminal apparatus. In the present species there is no vestige of cirrus-sac or vagina and not the least trace that I could discover of an external pore. Nor do I think that it would have been easy to have missed these structures were they present, particularly in a series of sagittal sections. I am, in fact, convinced that they are absent.

The eggs of this tapeworm do not lie in any space or spaces that can be strictly called a uterus. There are, however, spaces which suggest the remains of the uterus. These are not arranged in strict metamerism; but in a certain number of proglottids, and not by any means confined to a single proglottid, are large cavities such as is represented in the accompanying text-figure (text-fig. 120). These cavities are more or less circular and lie in the medullary region of the body. As a matter of fact, they are not at all full of eggs. Indeed, they are often quite empty; only sometimes are eggs to be seen lying within them

Text-fig. 120.



Two sections through portions of proglottids of the sexual worm.

The upper figure is a longitudinal section in the more anterior part of the body, showing the smaller ova lying among and to the inside of the longitudinal muscles (*l.*); these smaller ova lie in what is probably generative tissue, not clearly indicated in the drawing.

t. Transverse muscle fibres. *o.* Mature ova scattered through medulla and also at the opposite side of the figure in the cortex.

The lower figure represents a transverse section through a more posteriorly situated segment.

c. A cavity which may possibly represent a uterus; two spaces are shown in the cortex which may or may not belong to the same category. *l.* Longitudinal muscles. *o.* Ripe ova showing a nucleus. *t.* Transverse muscles.

and adherent to their walls. I doubt, therefore, whether these spaces are the remains of the uterus, or whether they are not rather cavities which have arisen in the medullary region perhaps by stretching of the walls of the body and consequent laceration. The eggs, in fact, lie scattered through the parenchyma, sometimes singly and more often in masses of various sizes, as is shown in the figure referred to. The eggs are not limited to the medullary region. It is clearly to be observed that they extend into the cortex (text-figs. 120, 121) a good way

Text-fig. 121.

Part of a transverse section through a proglottid of the sexually mature worm in which the ripe ova (*o.*) have been very deeply stained and are seen to be scattered through the cortex as well as the medulla.

l. Longitudinal muscles. *t.* Transverse muscles.

towards the external layer of the body-wall. They stop short, however, some way below it. It is quite certain that whether or no there may be remains of the uterus, some of the eggs lie scattered within the parenchyma. In the cortical parenchyma they are to be seen between the muscle-bundles and closely packed in masses. The appearance is, indeed, not at all unlike that which I have recently described in the tapeworm *Anoplotænia dasyuri* * in those parts where the cavities of the uterus were not so conspicuous; for in the latter worm there are uterine

* P. Z. S. 1911, p. 1012, text-fig. 213.

cavities lodging many, perhaps most, of the eggs. The present species is, as it were, a stage beyond that exhibited by *Anoplotænia dasyuri*. As is well known, the imbedding of the eggs in the parenchyma is not a novelty; for *Oochoristica* is a genus which is largely characterised by this very feature, though in this case the eggs are imbedded singly and there are not the heaps of eggs seen in the present species and perhaps in *Anoplotænia*. In *Anoplotænia*, however, the masses of eggs are usually in cavities of the uterus. In both *Oochoristica* and *Anoplotænia*, however, the scattered eggs are limited to the medullary region. But the peculiarity of the species with which I am dealing in the present paper is also known in other forms. Clerc * has figured eggs in the cortical region in a species of *Dilepis*.

I have some reason to think that the scattered eggs lie in the interstices of the network forming the ground-tissue of the worm; but in any case eggs were also seen lying in larger circular cavities. I believe that these cavities (shown in text-fig. 120) are not the remains of a uterus. They are, as it appears to me, to be directly compared with similar spaces to be seen in mature (but less mature than in the present instance) segments of *Inermicapsifer*, where I have described and figured them †. In this latter case I was able to bring forward some positive evidence to show that the spaces in question were not, and could not be, the isolated series of chambers left by a vanishing uterus. In the worm with which I am dealing in the present communication I am unable to furnish any of those proofs of the nature of the cavities in question. I can merely point out their general similarity to those of *Inermicapsifer*.

Although there were no traces of gonads like those of other tapeworms in this region of the body, I have succeeded in discovering what I regard as undoubtedly the generative tissue. The medulla was packed with ripe ova, which, as already said, stray into the cortical layers lying between the bundles of muscles. But at the line of junction of the cortex and medulla and lying in the latter is a continuous mass of tissue with interspersed nuclei, in and just outside of which eggs in various stages of development are to be seen. This is, as I think, undoubtedly to be regarded as a continuous layer of gonadial tissue. I cannot see any other obvious explanation of it. It is clearly totally unlike the ground-tissue of the tapeworm's body and forms a solid mass with darkly staining nuclei. Its association with developing ova seems to be final in the matter of argument. It is, however, possibly the case that this gonadial tissue is wholly or in part the origin of spermatozoa also; for testes like those of other tapeworms were not found in the present species. I have, however, no evidence of the presence of spermatozoa. The tissue itself is—save where developing ova

* Rev. Zool. Suisse, t. xi. 1903, pl. xi. figs. 75, 76.

† P. Z. S. 1912, p. 588, text-fig. 77. For the opposite view, see Janicki, Denkschr. Med.-Nat. Ges. Jena, xvi. (1911) p. 381, pl. xiv. figs. 25–27.

are present—naturally indistinctive. The only way of proving its testicular nature is the discovery of spermatozoa. An inability to find these is not of itself conclusive proof of the absence of testicular tissue. But an argument of weight in this direction is to be derived from a study of the ripe eggs. These are rather small as compared with some species and possess a very thick hyaline shell, which is with difficulty penetrated by staining reagents. Thus in many of my sections the eggs seem to be simply oval structureless bodies. In cases, however, where the staining has been more successful the true ovum within the shell becomes obvious. It consists of a single cell with a large nucleus. I say a single cell because there are not vitelline cells enclosed within the shell, anything in the nature of a vitelline body being completely absent. The absence of a vitelline gland is rare among tapeworms, but is known in the genus called on that very account *Avitellina**. In no case did I find this ovum in course of division—and I have examined a large number of individual ova in many segments. I infer, therefore, that no spermatozoa are formed in this individual worm and furthermore that there is no entry of spermatozoa from another individual—a fact which is also supported by the absence of a vagina. But it must be remembered that the host may not have contained in the bile-ducts another sperm-producing individual. It may be that fertilisation occurs outside the body. But this is clearly a mere suggestion for the present, though not repugnant to such evidence as there is.

There being no trace of the actual uterus in the middle region of the body, I naturally sought for these bodies elsewhere and made a series of sections from the anterior region of the body. I selected the rather thicker region which immediately follows the head and examined a piece cut from about 10 mm. behind the anterior extremity. Here, as I imagined, the immature uterus might be found or at any rate some trace of its existence. I could, however, find in this part no essential differences from the posterior region of the body which has just been described. The body was in the same way packed in places with the ripe ova, which were present everywhere in a less crowded state; indeed, they seemed to me to occur nearer to the external surface here than posteriorly. I found the eggs only just beneath the external cellular layer of the body-wall. The only conclusion that I can come to is that this worm possesses no uterus, or that it exists for a very transitory period only, and also that very possibly the sexes are separated as in the genus *Dioicocestus*. The specimen described here being a female, this conclusion is obviously based upon negative evidence only and is thus less valuable. It is, however, quite clear to my mind that the generative products develop simultaneously in the proglottids and that

* See Gough, Quart. Journ. Micr. Sci. vol. lvi. pt. 2, 1911, for an account of this genus.

therefore there is no growth of the worm when it has arrived at sexual maturity. This conclusion, which fits the facts that I am able to set forth, agrees also, it may be pointed out, with the very worm-like cysticercoid stage. There is, so to speak, not much necessity for this immature worm to grow in length before assuming the sexual condition. Far otherwise is it with the typical *Cysticerci*, which are provided with but short strobila as compared with the mature forms of their species. There is at the very least a relation between the two series of facts which is worth noting. It seems to me to be furthermore likely that at no period are there sexual ducts developed—at any rate, no female ducts. This latter circumstance, if true, is not new; for the absence of a female orifice has been asserted in more than one genus of worms belonging to more than one family. *Aporina* among the Anoplocephalidæ and many genera among the Acoleidæ are instances to the point. It is mainly, indeed, the plain absence of a cirrus-sac which leads me to believe that this worm possesses a diœcious habit so rare in this group.

§ *General Résumé and Systematic Position.*

It is, I think, obvious from the foregoing account of the sexual form of this worm that it is the representative of a new genus which differs in a good many particulars from any known form. It will be convenient to give a short résumé of the essential characters of this worm, for which the name already given to what I regard as the asexual form may be retained. My reasons for retaining the name of the asexual form are firstly that I have been able to give a more complete account of it than of the presumed sexual form of the same Cestode, and secondly that I cannot fully define the sexual form, concerning whose identity with the asexual form, moreover, some doubt may be considered to remain.

In any case the following are the principal characters of the sexual worm :—Length 86 mm., greatest breadth 6 mm. Head with two rows of hooks 16 in each row, the hooks of the anterior row twice the size of those of the second row. Suckers normal and unarmed. No neck; strobila consisting of numerous proglottids very short and not appreciably longer at posterior end of worm.

Body flat, thicker anteriorly. Cortex about the same diameter as medulla. Two layers of bundles of longitudinal muscular fibres in cortex. Water vascular tubes two on each side lying side by side; dorsal (?) tube with thick muscular walls. A transverse vessel in each proglottid forking round dorsal vessel to join ventral at two points. No water vascular network present. Nervous system consisting of a larger lateral trunk and two smaller trunks, one dorsal and one ventral, connected by many cords in each proglottid to main trunk. The sexes are apparently separate or the worm is protogynous or protandrous throughout.

Female organs consist of a layer of gonadial tissue lying in the medulla at its junction with the cortical layer from which ova are shed into the body, which they permeate even to the outer layers of the cortex. There is no trace of segmentally arranged gonads or of a uterus, nor are the eggs surrounded by any kind of "capsule." There is no vagina or female passage of any kind; the vitelline glands are totally absent. The ripe eggs are surrounded by a thick hyaline shell and none were observed to be dividing and no embryos were discovered in them. Thus it is possible that fertilisation occurs outside of the body.

These characteristics do not entirely fall in with those of any other family of tapeworms. They obviously point to an affinity with the Acoleidæ, but do not definitely necessitate the inclusion of this remarkable worm within that family.

§ *Anatomical Summary.*

It may be convenient to extract from the foregoing account of this new tapeworm the more remarkable anatomical facts which I have been able to make out.

(1) The absence of a marked scolex in the *Cysticercus* of a tapeworm which cannot be placed among the Bothriocephalids and of which therefore it would be expected that the scolex would be very prominent. And correlated with this the necessary assumption that, as in Bothriocephalids, the scolex only develops *pari passu* with the growth in maturity of the worm.

(2) The enormous size of the strobila as compared with the bladder—a rare condition among the Tetracotylea, but paralleled in *Cysticercus fasciolaris*.

(3) The very thick layer of muscle surrounding the dorsal vessel of the excretory system and the bifurcation of the transverse vessels round the dorsal vessel to open into the ventral water vascular tube.

(4) The total absence of generative ducts or (presuming that the species is dioecious) of the female tubes, which is, so far as I am aware, a unique anatomical character.

(5) The total absence of a uterus or of any trace thereof.

(6) The diffuse and non-metameric character of the ovaries, which are not sharply differentiated into relatively small bodies of a definite shape.

(7) The enormous quantity of eggs produced and their existence in quite anterior as well as posterior segments; the eggs are, moreover, found quite as abundantly in the cortical layer as in the medulla. The conditions observable in this part of the generative system are simply an exaggeration of what is to be met with in other genera, where the eggs come to be ultimately scattered through the medullary parenchyma.